What is claimed is:

1. A motion vector estimation apparatus for obtaining motion vectors of a second frame with reference to a first frame, comprising:

a vertical motion vector calculation part which calculates vertical motion vectors of the second frame with reference to the first frame;

an offset control part which decides vertical reference positions when calculating horizontal motion vectors of the second frame according to the vertical motion vectors; and

a horizontal motion vector calculation part which calculates the horizontal motion vectors of the second frame in lines according to the vertical reference positions.

2. The motion vector estimation apparatus as claimed in claim 1, wherein the vertical motion vector calculation part comprises:

a vertical pixel value storage which adds values of pixels of each of horizontal lines forming the first frame to calculate vertical sums, and stores the vertical sums by horizontal line; and

a first SAD value calculator which calculates differences between the vertical sums of the first frame and vertical sums of the second frame calculated by adding values of pixels of each of horizontal lines forming the second frame, and processes the differences into absolute values to calculate sums of absolute difference(SAD) values.

3. The motion vector estimation apparatus as claimed in claim 2, wherein the first SAD value calculator comprises:

an adder which adds the differences between the vertical sums of the first frame and the vertical sums of the second frame; and

a vertical motion vector selection unit which obtains absolute values for values added in the adder, and selects the least absolute value of the absolute values as a vertical motion vector.

4. The motion vector estimation apparatus as claimed in claim 3, wherein the first SAD value calculator calculates SAD values based on an expression:

$$V(u) = \sum_{i=sr}^{M-sr} \left| \sum_{j=0}^{N-1} Vp(i+u, j) - Vn(i, j) \right|,$$

wherein M and N denote a width region and a height region, respectively, of the first frame or the second frame, sr denotes a search range, i and j denote a pixel position in the

width region and the height region, respectively, $V(u)$ denotes one of the SAD values, Vp denotes a function for calculating a horizontal line pixel value of the first frame, Vn denotes a function for calculating a horizontal line pixel value of the second frame and ***u*** denotes an amount of horizontal motion within a search range (*-sr, sr*).

5. The motion vector estimation apparatus as claimed in claim 2, wherein the horizontal motion vector calculation part comprises:

a horizontal pixel value storage which adds values of pixels of each of vertical lines of the first frame to calculate horizontal sums, and stores the horizontal sums by vertical line; and

a second SAD value calculator which calculates SAD values from differences between the horizontal sums of the first frame and the horizontal sums of the second frame, wherein the SAD values are calculated for horizontal lines decided according to the vertical reference positions.

6. The motion vector estimation apparatus as claimed in claim 5, wherein the second SAD value calculator comprises:

a second adder which adds the differences between the horizontal sums of the first frame and the horizontal sums of the second frame; and

a horizontal motion vector selection unit which obtains absolute values for values added in the second adder, and selects the least absolute value of the absolute values as a horizontal motion vector.

7. The motion vector estimation apparatus as claimed in claim 6, wherein the second SAD value calculator calculates the SAD values based on an expression:

$$H(v) = \sum_{j=sr}^{N-sr}\left|\sum_{i=0}^{M-1}(Vp(i+mv, j+v) - Vn(i+mv, j))\right|,$$

where M and N denote a width region and a height region, respectively, of the first frame or the second frame, sr denotes a search range, i and j denote a pixel position in the width region and the height region, respectively, mv denotes a vertical motion vector, $H(v)$ denotes a SAD value, Vp denotes a function for calculating a horizontal line pixel value of the first frame, Vn denotes a function for calculating a vertical line pixel value of the second frame, and v denotes the position of a pixel that is changed in consideration of a vertical reference position obtained by the calculated vertical motion vector.

8. A method of estimating motion vectors to obtain motion vectors of a second frame with reference to a first frame, the method comprising:

calculating vertical motion vectors of the second frame with reference to the first frame;

deciding vertical reference positions when calculating horizontal motion vectors of the second frame according to the vertical motion vectors; and

calculating the horizontal motion vectors of the second frame in lines according to the vertical reference positions.

9. The method of estimating motion vectors as claimed in claim 8, wherein the calculating of the vertical motion vector comprises:

adding values of pixels of each of horizontal lines forming the first frame to calculate vertical sums, and storing the vertical sums by horizontal line; and

calculating differences between the vertical sums of the first frame and vertical sums of the second frame calculated by adding values of pixels of each of horizontal lines forming the second frame, and processing the differences into absolute values to calculate sums of absolute difference (SAD) values.

10. The motion vector estimation method as claimed in claim 8, wherein the calculating of the horizontal motion vector comprises:

sequentially storing horizontal sums for lines of the first frame; and

calculating SAD values from differences between the horizontal sums for the lines of the first frame and horizontal sums for lines of the second frame for horizontal lines decided according to the vertical reference positions.

11. A motion vector estimation apparatus for obtaining motion vectors of a second frame with reference to a first frame, comprising:

a vertical motion vector calculation part which calculates vertical motion vectors of the second frame with reference to the first frame; and

a horizontal motion vector calculation part which reduces calculation amounts of horizontal motion vectors of the second frame based upon the vertical motion vectors.